REMARKS

In response to the final Office Action mailed July 7, 2003, please enter the amendments below and consider the following remarks.

Claims 1-20 are presently in the application.

The present invention relates to an oligomerization process in which feedstocks, which have not been previously desulfurized and include sulfur-containing molecules and contain at least 10 ppm S, are contacted with a hydrotreating catalyst in the absence of hydrogen, optionally in the liquid phase. The catalyst is a heterogeneous catalyst selected from supported reduced metals, metal oxides, metal sulfides and combinations thereof. Preferred catalysts include mixed nickel and molybdenum oxides or mixed cobalt and molybdenum oxides. The process can oligomerize sulfur compounds so that sulfur-containing feedstocks can be treated without deactivating the catalysts. Accordingly, untreated refinery streams, pulp and paper byproducts, sugars, natural fatty acids and alcohols can be used as oligomerization feedstocks without preliminary desulfurization.

Claims 1, 3, 12-14 and 16-20 have been amended to replace the term "hydrocarbon feedstock" with "feedstock" for the purposes of overcoming the Examiner's objection that "pulp and paper, sugars, natural fatty acids and alcohols do not belong to the group of hydrocarbon feedstocks." Also, claim 1 has been amended to indicate that the sulfur-containing feedstocks have not been previously subjected to a desulfurization process involving hydrogen treatment, support for which is found at page 4, lines 15 to 18, page 5, lines 23 to 26 and page 6, lines 18 to 22 of the specification.

Rejections Under 35 U.S.C. § 103(a)

Claims 1-19 have been rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 4,788,376 to Mazurek et al. (Mazurek) in view of U.S. Patent No. 5,157,201 to Norris.

This rejection is respectfully traversed.

Norris actually teaches *away* from the present invention inasmuch as it teaches:

> During oligomerization, however, the sulfur species tend to become incorporated in the higher olefins. Although higher olefins containing sulfur can be used as feedstock for various chemical processes, the sulfur in the higher olefin hydrocarbon streams typically contribute to the production of resultant product streams which are lower in quality than if sulfur were not present in, or removed from, the olefinic hydrocarbon feedstream. (Column 1, lines 47-55).

Furthermore, Norris' invention is solely directed to removing sulfur from feeds using metal oxides to *adsorb* sulfur species (column 4, lines 24-25) at low temperatures of 50° to 175°C (122° to 347°F) (column 4, lines 39-40), rather than treating at the presently claimed temperatures of 392° to 600°F. Thus, one skilled in the art would not simply substitute a sulfur-containing propylene feed in the process of Mazurek, but would employ an adsorbent at moderate temperatures as taught by Norris.

To otherwise interpret Norris disregards the teaching of the reference as a whole. It is well understood that the teaching of a reference *as a whole* should be considered. In *In re Wesslau*, 353 F.2d 238, 147 USPQ 391 (CCPA 1965), the court cautioned that "it is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art." In *Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve, Inc.*, 796 F.2d 443, 230 USPQ 416 (Fed. Cir. 1986), *cert. denied*, 484 U.S. 823 (1987), *on remand*, 10 USPQ2d 1929 (N.D. Calif. 1989), the Federal Circuit held that a single line in a prior art reference should not be taken out of context and relied upon with the benefit of hindsight to show obviousness. Rather, a reference should be considered as a whole, and portions arguing against or teaching away from the claimed invention must be considered.

The Examiner has disregarded Norris' differences earlier pointed out by applicants on the basis that Norris is cited ' to teach the 'conventionality' of sulfur in the feed and not

the temperature as interpreted by applicants." However, applicants maintain that the Examiner must apply the *whole* reference and not selections thereof in considering whether one skilled in the art at the time the invention was made would have found it obvious to combine Norris with Mazurek. Applicants submit that Norris' teachings, supra, of the disadvantages of oligomerizing sulfur-containing feeds, and the avoidance of such disadvantage using Norris' low temperature adsorption of sulfur species, clearly teach *away* from oligomerizing Norris' sulfur-containing feedstocks with the hydrotreating catalyst and oligomerizing conditions of Mazurek.

The Examiner has stated at page 5, lines 1 and 2 of her office action that "applicants have not demonstrated the criticality of 1% sulfur in the feed." However, the advantage of a process capable of operating with such high sulfur feeds is quite manifest from a commercial standpoint inasmuch as the present process can and does dispense with costly sulfur removal treatments prior to olefin oligomerization. Examples 3 and 5 of the present application show operation of the invention with 1 wt.% thiophene feeds being converted at more than 95% conversion of thiophene to oligomers, *at least two orders of magnitude beyond the levels contemplated by Norris.*

The Examiner's statement bridging pages 4 and 5 that "[a]pplicants' 95% sulfur conversion would naturally result from the process produced by the combined teachings of Mazurek et al. and Norris because the same conditions and feed amounts would yield a similar conversion percentage" is incorrect. One skilled in the art applying Norris to Mazurek would not employ the high temperatures required by the present invention inasmuch as Norris suggests the adsorption of sulfur-containing species at low temperatures as discussed above.

Finally, Norris actually teaches away from the present invention inasmuch as it teaches that "[t]he olefin feedstock is typically first treated to remove deleterious quantities of impurities such as organic sulfur" (see, column 6, lines 47 to 55). In contrast, the present claims specifically recite that the feed is not preliminarily desulfurized.

Clearly, one skilled in the art familiar with Norris would be led away from directly oligomerizing a sulfur-containing feed as required by the present claims.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present invention is neither disclosed nor suggested by the combination of Mazurek and Norris. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-5 and 8-15 have been finally rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent No. 4,098,839 to Wilms et al. (Wilms) in view of Norris. Wilms is cited as disclosing oligomerization of C_2-C_5 olefins over a catalyst containing molybdenum and cobalt and/or nickel supported on alumina which is activated in an oxidizing atmosphere to provide metal oxides. Wilms describes a catalyst "substantially insensitive to sulfur . . . components in the olefin feedstocks" (column 2, lines 10-12) and teaches feedstocks containing 50 ppm sulfur (column 6, lines 21-22). Norris is again cited as teaching that higher olefin plants typically use a butylene feedstock which normally contains 5-50 ppm of various sulfur species, and that sulfur species are incorporated into higher olefins during oligomerization.

The Examiner concludes it would be obvious to oligomerize sulfur- and butene-containing feedstocks with the catalysts specified in the present claims in view of Wilms because Norris teaches use of sulfur-containing feeds for oligomerization as well as incorporation of sulfur into higher olefins during oligomerization. The Examiner argues selecting any combination of metals and metal oxides would be obvious to one skilled in the art, including applicants' NiMo/alumina or mixed NiMo or CoMo oxides, given the reference's teaching that such catalysts are known to accomplish the desired conversion.

This rejection is respectfully traversed.

Applicants rely on the arguments made respecting the Wilms and Norris combination of references in their earlier responses.

Moreover, it is noted that Wilms actually teaches away from oligomerizing feeds containing significant amounts of sulfur. Wilms teaches that catalysts used in oligomerizing olefins are sensitive to sulfur, "thereby requiring that such substances be substantially removed from the gaseous olefins prior to oligomerization" (column 1, lines 12 to 21). Although Wilms teaches catalysts which are insensitive to sulfur, the general process temperatures of 80° to 180°C (176° to 356°F) (column 3, lines 42 to 43) are significantly lower than the 392° to 600°F of claim 1 of the present invention. Moreover, Wilms fails to teach the severe conditions from combining high temperatures and liquid phase conditions required by present claims 2, 4 and 7 to 10.

Wilms' Comparative Examples 4 and 5 use supported MoO_3 catalyst and MoS_2 catalyst, respectively, to process a *propylene* feed containing about 50 ppm sulfur. Wilms' Example 2 processes a *butene* mixture at 225°C but makes no mention of sulfur. Moreover, Wilms teaches that the product yield obtained in the absence of sulfur in the feed "had almost the same composition than the one obtained by Example 1" with 50 ppm sulfur in the feed. See, Wilms, column 6, lines 26 to 31. Thus Wilms teaches away from the present invention's process of claim 3 which oligomerizes sulfur-containing molecules, because one skilled in the art would expect no significant difference between sulfur-containing feeds and sulfur-free feeds for olefin oligomerization. Moreover, this further supports the importance of the high temperatures required by the present process in achieving oligomerization of sulfur-containing feeds. In the absence of the high temperatures required by the present invention, one skilled in the art would expect no significant difference in composition between product composition for sulfur- and non-sulfur-containing oligomerization feeds. The criticality of temperature is further borne out by the comparative examples set out in applicants' specification, which were earlier discussed in applicants' earlier responses.

The Examiner has deprecated applicants' arguments concerning their comparative examples at page 10, lines 17-18, of the July 7, 2003 Office Action on the basis that

"[s]ince Wilms et al.'s disclosure encompasses the use of sulfur containing feeds, it is considered to read on applicants' claims." This statement is incorrect, inasmuch as the present claims are distinguished from Wilms, inter alia, in terms of higher process temperatures and absence of preliminary desulfurization requirements not found in Wilms. Tellingly, the Examiner has not made an anticipation rejection based on Wilms.

The Examiner also argued that "conversion product differences between a non-sulfur containing feed and a sulfur containing feed are not the subject of applicants' claims" and that one "can not distinguish the claims by differences not defined in the claims." However, applicants respectfully submit that such differences are defined in the claims because claim 3 *requires* oligomerizing sulfur compounds which would clearly result in differences between products formed in the absence or presence of sulfur. In contrast, Wilms' products in the absence or presence of sulfur are described as "almost the same."

Moreover, with regard to claims 1-5 and 8-15, the combination of Wilms and Norris fails to disclose or suggest the significantly higher operating temperatures in the presence of sulfur as required by the present claims. Although Wilms' Example 2 shows oligomerization *in the absence of sulfur* at 225°C, the reference generally discloses oligomerizing at relatively low temperatures of 40°-180°C (104°-358°F), particularly in the presence of sulfur. Similarly, Norris discloses oligomerizing at low temperatures of 50° to 175°C (122° to 347°F) (column 4, lines 39-40). In contrast, the present invention employs higher temperatures (392°-600°F) which enhance reactivity of the catalyst to form oligomers at conditions "more severe than typical conditions used to conduct oligomerizations/polymerizations" (specification at page 6, lines 12-15). Finally, it is urged that neither Wilms nor Norris suggests the process of present claims 12 and 14 wherein the hydrocarbon feedstock comprises greater than 50 ppm sulfur and up to about 1 wt.% (10000 ppm) of sulfur-containing molecules.

The Examiner contends at the paragraph bridging pages 7 and 8 of the July 7, 2003 Office Action that "applicants' slightly higher minimum temperature range is not considered to be a patentable distinction over the temperature" inasmuch as Wilms' lower temperatures "would accomplish a similar conversion to the lower end of applicants' claimed temperature range because the temperatures are close enough that similar conversions would be accomplished." The Examiner further notes that "[a]pplicants have not submitted evidence of criticality with respect to the claimed range. In response, applicants respectfully direct the Examiner's attention to Figure 1 of the present specification which shows a significantly greater effectiveness for diene conversion at a temperature within the presently claimed range (450°F) as compared to temperatures within the disclosed range of Wilms--176°F to 356°F, i.e., 300°F. It is respectfully submitted that this advantage of the presently claimed process is nowhere suggested by Wilms' teachings. Accordingly, one skilled in the art would not likely find it advantageous to employ temperatures beyond the 356°F limit of Wilms. Moreover, it is noted that Wilms own disclosure shows that the products obtained without the presence of sulfur was "almost the same composition" as that obtained with sulfur in the feed (column 6, lines 29 to 31), which suggests the oligomerization in the present invention does not occur at Wilms' lower temperatures.

Finally, one skilled in the art familiar with both Wilms and Norris would be led away from the present invention inasmuch as Norris, who teaches higher levels of sulfur than Wilms (up to about 100 ppm S) (column 5, lines 26 to 27), removes sulfur by adsorption rather than by oligomerization of sulfur-containing species as contemplated by Wilms (50 ppm S) (column 6, lines 21 to 22). Indeed, Norris actually discloses treating olefin feedstocks to remove sulfur even *before* subjecting the olefins to the adsorption step. Norris teaches that "[t]he olefin feedstock is typically first treated to remove deleterious quantities of impurities such as organic sulfur" by a procedure including selective catalytic hydrogenation (see, column 6, lines 47 to 55). In contrast, the present claims specifically recite that the feed is not preliminarily desulfurized by hydrogen

treatment. Clearly, one skilled in the art familiar with Norris would be led away from directly oligomerizing a sulfur-containing feed as required by the present claims.

Given these distinctions, it is respectfully submitted that the subject matter of the present claims is neither disclosed nor suggested by the combination of Wilms and Norris. Accordingly, withdrawal of this rejection under 35 USC § 103(a) is respectfully requested.

The Examiner has rejected claims 19-20 which can use light FCC gasoline hydrocarbon as feedstock over 1) Mazurek and Norris in view of U.S. Patent No. 5,000,837 to Harandi or 2) Wilms and Norris in view of U.S. Patent No. 5,000,837 to Harandi. The Examiner cites Mazurek and Norris or Wilms and Norris as above, and argues Harandi teaches that FCC gasolines are known sources of olefins. The Examiner further argues that inasmuch as Mazurek and Wilms "do not limit the source of olefins," one skilled in the art would find it obvious to obtain olefins from an FCC as the feedstock of the presently claimed process.

This rejection is respectfully traversed.

These combinations of references suffer from the same deficiencies pointed out above respecting Mazurek and Norris, and Wilms and Norris as was argued above. Moreover, despite Harandi teaching FCC light gas can contain olefins, there is no suggestion of oligomerizing the sulfur compounds in the feed as required by claim 19 which depends from claim 3. With regard to the feeds of presently amended claim 20, it is respectfully submitted that none of the references cited in this rejection would direct one skilled in the art to utilize such feedstocks. Moreover, none of the references suggests the higher temperatures or the absence of a preliminary desulfurizing step using hydrogen treatment as required by the present claims.

In view of the foregoing arguments, it is respectfully submitted that the subject matter of claims 19 and 20 is not obvious in view of the three references cited. Accordingly, withdrawal of this rejection is respectfully requested.

Claims 1-3, 8, 9, 11, 15, 19 and 20 have been rejected under 35 USC 102(b) as being anticipated by U.S. Patent No. 5,792,891 to Adams et al. (Adams). The Examiner contends Adams teaches isomerizing FCC gasoline feed containing C4 to C10 olefins in the presence of methanol over a zeolite or alumina catalyst, as well as processing the feed to remove undesirable sulfur, implying the presence of trace amounts of sulfur which would be inherently oligomerized.

This rejection is respectfully traversed.

Adams, relating to etherification of iso-olefins, actually teaches away from the present invention inasmuch as it requires a hydrogenation step prior to isomerization which one skilled in the art would expect to further remove sulfur present in the feed (column 5, line 24 to column 7, line 15). Accordingly, it is respectfully submitted that Adams neither discloses nor suggests the presently claimed invention and withdrawal of this rejection is therefore respectfully requested.

CONCLUSION

Applicants respectfully submit that the foregoing arguments, in light of the amendments made herewith, obviate all of the outstanding rejections in this case and place the application in condition for immediate allowance. Allowance of this application is therefore earnestly solicited.

Respectfully submitted,

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